

CLAIMS

What is claimed is:

- 1 1. A method for forming a pole tip, comprising:
2 forming a pole tip layer of magnetic material;
3 adding a layer of polyimide precursor material above the pole tip layer;
4 curing the polyimide precursor material;
5 adding an oxygen etch resistant resist layer above the layer of polyimide precursor
6 material;
7 patterning the etch resistant layer;
8 exposing the polyamide precursor material layer to oxygen-containing plasma;
9 removing exposed portions of the cured polyimide precursor material for
10 exposing portions of the pole tip layer; and
11 removing the exposed portions of the pole tip layer for forming a pole tip.
- 1 2. A method as recited in claim 1, wherein the curing converts at least a substantial
2 portion of the polyimide precursor material to at least one of a polyimide and a
3 polyimide-like material.
- 1 3. A method as recited in claim 1, wherein the oxygen etch-resistant layer is a
2 silicon-containing resist.

- 1 4. A method as recited in claim 1, wherein the oxygen etch-resistant layer consists of
2 a sputtered film.
- 1 5. A method as recited in claim 1, wherein the exposed portions of the cured
2 polyimide precursor material are removed by reactive ion etching.
- 1 6. A method as recited in claim 1, wherein the exposed portions of the pole tip layer
2 are removed by milling.
- 1 7. A method as recited in claim 1, further comprising adding a first layer of material
2 resistant to chemical mechanical polishing above the pole tip layer.
- 1 8. A method as recited in claim 1, further comprising adding a layer of nonmagnetic
2 material for substantially encapsulating the pole tip.
- 1 9. A method as recited in claim 8, further comprising adding a second layer of
2 material resistant to chemical mechanical polishing above the layer of
3 nonmagnetic material.
- 1 10. A method as recited in claim 1, wherein the remaining portion of the pole tip layer
2 has a width of less than about 100 nm.
- 1 11. A pole tip formed according to the method recited in claim 1.

1 12. A method for forming a pole tip, comprising:
2 forming a pole tip layer of magnetic material;
3 adding a first layer of material resistant to chemical mechanical polishing above
4 the pole tip layer;
5 adding a layer of polyimide precursor material above the first layer of material
6 resistant to chemical mechanical polishing;
7 baking the polyimide precursor material;
8 adding an etch resistant layer above the layer of polyimide precursor material;
9 patterning the etch resistant layer;
10 removing exposed portions of the polyimide precursor material for exposing
11 portions of the pole tip layer;
12 removing the exposed portions of the pole tip layer for forming a pole tip;
13 adding a layer of nonmagnetic material for substantially encapsulating the pole
14 tip;
15 adding a second layer of material resistant to chemical mechanical polishing
16 above the layer of nonmagnetic material; and
17 polishing for removing material above the first layer of material resistant to
18 polishing.

1 13. A method for forming a magnetic structure, comprising:
2 forming a layer of magnetic material;

3 adding a first layer of material resistant to chemical mechanical polishing above
4 the pole tip layer;
5 adding a layer of polyimide precursor material above the first layer of material
6 resistant to chemical mechanical polishing;
7 baking the polyimide precursor material;
8 adding an etch resistant layer above the layer of polyimide precursor material;
9 patterning the etch resistant layer;
10 removing exposed portions of the polyimide precursor material for exposing
11 portions of the layer of magnetic material;
12 removing the exposed portions of the layer of magnetic material;
13 adding a layer of nonmagnetic material for substantially encapsulating the
14 remaining portion of the layer of magnetic material; and
15 polishing for removing material above the first layer of material resistant to
16 polishing.

1 14. A method as recited in claim 13, wherein the etch resistant layer is formed of a
2 silicon-containing resist.

1 15. A method as recited in claim 13, wherein the etch resistant layer is a glass-like
2 material.

- 1 16. A method as recited in claim 13, wherein the baking converts at least a substantial
2 portion of the polyimide precursor material to at least one of a polyimide and a
3 polyimide-like material.
- 1 17. A method as recited in claim 13, wherein the layer of nonmagnetic material has a
2 thickness at least as great as a thickness of the layer of magnetic material.
- 1 18. A method as recited in claim 13, wherein the layer of nonmagnetic material has a
2 thickness greater than a thickness of the layer of magnetic material, wherein the
3 layer of nonmagnetic material forms a plane that is above a top surface of the
4 layer of magnetic material.
- 1 19. A method as recited in claim 13, further comprising adding a second layer of
2 material resistant to chemical mechanical polishing above the layer of
3 nonmagnetic material.
- 1 20. A method as recited in claim 19, wherein a lower surface of the second layer of
2 material resistant to chemical mechanical polishing lies above a plane positioned
3 above a plane extending along an upper surface of the pole tip.
- 1 21. A method as recited in claim 13, wherein the magnetic structure has a width of
2 less than 100 nm.

- 1 22. A magnetic storage system, comprising:
2 magnetic media;
3 at least one head for reading from and writing to the magnetic media, each head
4 having a pole tip formed according to the method of claim 1;
5 a slider for supporting the head; and
6 a control unit coupled to the head for controlling operation of the head.
- 1 23. A perpendicular pole tip structure, comprising:
2 a pole tip layer of magnetic material having a top surface, a bottom surface, and
3 sides extending between the top and bottom surface;
4 layers of non-magnetic materials surrounding the layer of magnetic material
5 towards the sides of the pole tip layer; and
6 interface layers above the non-magnetic material, portions of the interface layers
7 lying along a plane substantially parallel to the top surface of the pole tip
8 layer;
9 wherein portions of the interface layers taper towards the pole tip layer at a slope
10 that is from about one to about five times a thickness of the pole tip layer,
11 where the thickness of the pole tip layer is defined between the top and
12 bottom surfaces thereof.
- 1 24. A perpendicular pole tip structure as recited in claim 23, wherein each of the
2 interface layers includes a layer of chemical mechanical polishing resistant
3 material.

- 1 25. A perpendicular pole tip structure as recited in claim 23, further comprising a
2 layer of chemical mechanical polishing resistant material above the top surface of
3 the pole tip layer.
- 1 26. A magnetic storage system, comprising:
2 magnetic media;
3 at least one perpendicular head for reading from and writing to the magnetic
4 media, the head comprising:
5 a pole tip layer of magnetic material having a top surface, a bottom
6 surface, and sides extending between the top and bottom surface;
7 layers of non-magnetic materials surrounding the layer of magnetic
8 material towards the sides of the pole tip layer; and
9 interface layers above the non-magnetic material, portions of the interface
10 layers lying along a plane substantially parallel to the top surface
11 of the pole tip layer, wherein portions of the interface layers taper
12 towards the pole tip layer at a slope that is from about one to about
13 five times a thickness of the pole tip layer, where the thickness of
14 the pole tip layer is defined between the top and bottom surfaces
15 thereof;
16 a slider for supporting the head; and
17 a control unit coupled to the head for controlling operation of the head.

1 27. A magnetic storage system as recited in claim 26, wherein each of the interface
2 layers includes a layer of chemical mechanical polishing resistant material.

1 28. A magnetic storage system as recited in claim 26, further comprising a layer of
2 chemical mechanical polishing resistant material above the top surface of the pole
3 tip layer.